

**PROGRESS REPORT
FOR
SECTOR APPLICATIONS RESEARCH PROGRAM-WATER AND CLIMATE
NOAA CLIMATE PROGRAM OFFICE**

Award Number: NA08OAR4310694

Project Title: In With the Old: Evaluation of Paleo Data in Drought Planning for California
Period Covered by this Report: 01/12/2009-04/30/2009

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A. Project objectives

Paleoclimate data may benefit water managers who are planning for drought. This project evaluates incorporation of paleoclimate data into California Urban Water Management Plans (UWMP) following five objectives:

- 1) Apply paleohydrologic data to individual water provider assessments of water supply reliability under single and multi-year drought.*
- 2) Evaluate results to determine if paleohydrologic data indicate vulnerabilities to drought.*
- 3) Communicate results to water providers via workshops and reports.*
- 4) Make a recommendation to incorporate paleohydrologic data into UWMP guidelines, if indicated.*
- 5) Facilitate this type of application to other water providers through a set of guidelines, methods, and paleodata sources via a web page, newsletter article, and brochure.*

B. Project status

1. Personnel and meetings

A student enrolled in the UA Water Certificate Program, Melissa Mauzy, was hired in January to work (0.5 FTE) on the project. Melissa has since applied for and been accepted into the UA Department of Geography graduate program starting in the fall. She will remain on the project through the summer and fall. She has a background in physical science and a great interest in water policy, so is perfect for this project.

In January, we had a meeting with our California Department of Water Resources (CDWR) collaborator, Jeanine Jones, to discuss project design and selection of Urban Water Management Plans (UWMPs) for analysis. Jeanine went over some of the details of the different water providers from the plans she selected, their locations and sources of water. The 22 UWMP chosen are attached at the end of this progress report

Also in January, Melissa met with Dan Griffin, a graduate student here who has done quite lot of dendrochronological reconstructions in California and who has acted as an informal (unfunded) consultant for the project.

2. Tasks that have been completed or are in progress

Melissa devoted the first four months of the project to database design, literature review, and reading and analysis of the 22 UWMPs. Melissa and Connie have had weekly meetings on the project to assess Melissa's progress. As of this progress report we have made significant progress on objectives 1, 2 and 3, described below.

1. Apply paleohydrologic data to individual water provider assessments of water supply reliability under single and multi-year drought.

All 22 UWMP have been read and a strategy has been developed to prioritize UWPM analyses based on sources of water, compliance with state guidelines, and source of instrumental data.

An initial database was developed that includes each providers' sources of water, population, projected population growth, location, historical precipitation or streamflow, historical instrumental record analyzed by the provider, length of historical record, single-year drought scenario considered, and multi-year drought scenario considered.

Analysis of instrumental and paleoclimate data records required the development of an additional database. This database was developed, and the instrumental streamflow and precipitation records each water provider used, have been downloaded to the database. For each plan, we have tried to use the same streamflow or precipitation record used by the provider, although this is not always stated. These data have been obtained from the USGS (gage records), the National Climatic Data Center, the California Climate Data Archive (CalClim), or the Western Regional Climate Center (precipitation data). Analysis of these records is in progress.

Identification and selection of paleohydrologic data is also in progress. California climate zones have been identified and paleoclimate data selected corresponds to the climate zones of each provider's water resources. Paleoclimatic data used include published reconstructions of cool season precipitation and annual streamflow, as well as

tree-ring chronologies from exceptionally moisture-sensitive blue oaks. Many of these are archived at the NOAA Paleoclimatology Branch World Data Center for Paleoclimatology. A few not-yet-published reconstructions are being obtained from researchers. Paleoclimate data for a number of plans have been downloaded and analysis has begun.

2. Evaluate results to determine if paleohydrologic data indicate vulnerabilities to drought.

UWMP guidelines ask providers to create drought mitigation scenarios based on single-year and three-year droughts. Most providers do provide single and multi-year drought scenarios (three years or sometimes more). A first step in the assessment of the plans is to assess what providers have indicated to be their worst single and multiple-year droughts in the context of the instrumental records they indicated they have used in the assessment (if provided).

The next step, which we have begun, is to evaluate these droughts in the context of the paleoclimatic records to determine if the UWMP contain vulnerabilities to drought. Analysis includes a comparison of the worst drought period identified in the plans with the frequency of droughts of that length in the longer reconstruction records, and an assessment of the range of drought duration that have occurred over the paleo period.

3) Communicate results to water providers via workshops and reports.

A draft version of a results report to be delivered to water providers is being developed, and is attached at the end of this progress report. We will be consulting with Jeanine Jones in the next month to make sure the final format is appropriate and useful to water providers.

C. Products, presentations, and announcements related to this project:

Poster presentation was delivered at:

Water Resources Research Center 2009 Annual Conference
"Best Practices for Stakeholder Engagement in Water Resources Planning"
Tuesday, March 17, 2009
The University of Arizona, Student Union Memorial Center Ballroom
Tucson, Arizona

D. Upcoming activities

We are continuing to compare paleoclimate data to UWMP single and multi-year drought scenarios. As well, evaluation of these results to determine if paleohydrologic data indicate

vulnerabilities to drought, based on the longer paleoclimatic records, is continuing. Both of these steps are data intensive and progress will continue into summer 2009.

The draft reports to water providers will be developed further. Spatial analysis using GIS techniques will relate climate zones to water providers' resources and delivery areas. This aspect of the report has yet to be developed but will be incorporated into draft versions before consultation with the CDWR collaborator.

A literature review is ongoing and development of the final report, the water provider guidelines, the newsletter, the webpage, and the brochure will rely on this literature review. These activities will be completed this summer after data analysis is complete.

Workshops are planned for fall 2009 or perhaps winter 2010, and dates will be set at the second meeting with the CDWR collaborator, Jeanine Jones, in late summer 2009.

California Urban Water Management Plans Selected for Analysis

1. California Water Service Company Salinas District
2. Casitas Municipal Water District
3. City of Ceres
4. East Bay Municipal Utility District
5. East Valley Water District
6. El Dorado Irrigation District
7. City of Gilroy
8. Goleta Water District
9. Humboldt Bay Municipal Water District
10. Marin Municipal Water District
11. Metropolitan Water District of Southern California
12. City of Napa
13. Nevada Irrigation District
14. Paradise Irrigation District
15. City of El Paso de Robles
16. Placer County Water Agency
17. City of Sacramento
18. San Francisco Public Utilities Commission
19. City of Santa Cruz
20. Sonoma County Water Agency
21. Soquel Creek Water District
22. City of Ukiah

Example of Results

East Bay Municipal Utility District (EBMUD)

Water supply

East Bay Municipal Utility District's primary source of water is the Mokelumne River contributing to up to 90 percent of the water that serves 1.3 million people in 20 incorporated cities and 15 unincorporated communities in Alameda and Contra Costa Counties. The Mokelumne River watershed is northeast of the Sacramento-San Joaquin Delta on the western slope of the Sierra Nevada. Supply and conveyance facilities include Pardee and Camanche Reservoirs, and the Mokelumne Aqueducts. During drought periods, the Mokelumne River can no longer meet EBMUD's projected customer demands, even with 25 percent rationing imposed on total customer demand. EBMUD's water supply showed signs of stress during the 1976-77 and the 1987-92 droughts. For these reason's we focused our analysis of EBMUD's drought vulnerability on the Mokelumne River water source.

EBMUD drought scenarios

EBMUD's primary analysis of drought scenarios was based on surface flow of the Mokelumne River at the USGS gauge 11319500. Additional surface flow information was used from USGS gauges 11318500, 11317000, 11316800, 11316700, 11316670, 11316610, 11316605, 11316100, 11315900, 11314500, 11314000, 11313510, 11315030, 11315000, 11313472, 11313477, 11313485. EBMUD also considered precipitation data from 4 climate stations, Salt Springs (047689), Tiger Creek (048928), Calaveras Big Trees (041277) and Caples Lake. Our analysis of their drought scenario focused on their primary source USGS gauge 11319500.

The length of record EBMUD considered for their drought scenario spanned the years 1930-2004. They determined that 1986 would be an appropriate base year for establishing normal conditions. This decision was based on the fact that 1986 was the last year when consumption was not significantly influenced by dry weather or a drought management program. EBMUD single year drought scenario is based on the conditions that existed in 1976. EBMUD multi-year drought scenario is based on the conditions that existed from 1976-78 assuming 1978 had not been a wet year.

Summary of results

EBMUD indicated that the 1976 drought year was their worst water year. Our analysis in Figure 1 shows that in fact the 1977 water year was the worst water year from the record they used. EBMUD indicated 1976-78 is their worst 3-year drought period assuming 1978 had not been a wet year. This assumption complicates analysis of multi-year drought. Figure 2 shows that 1988-1990 would have been a more appropriate choice for analysis. The longest run of below average years in the instrumental period is 8 years, while it was 9 years in the reconstruction. There have been 18 3-yr runs of below average flows in the reconstruction

Figure 1. Analysis of EBMUD's instrumental record for single-year drought.

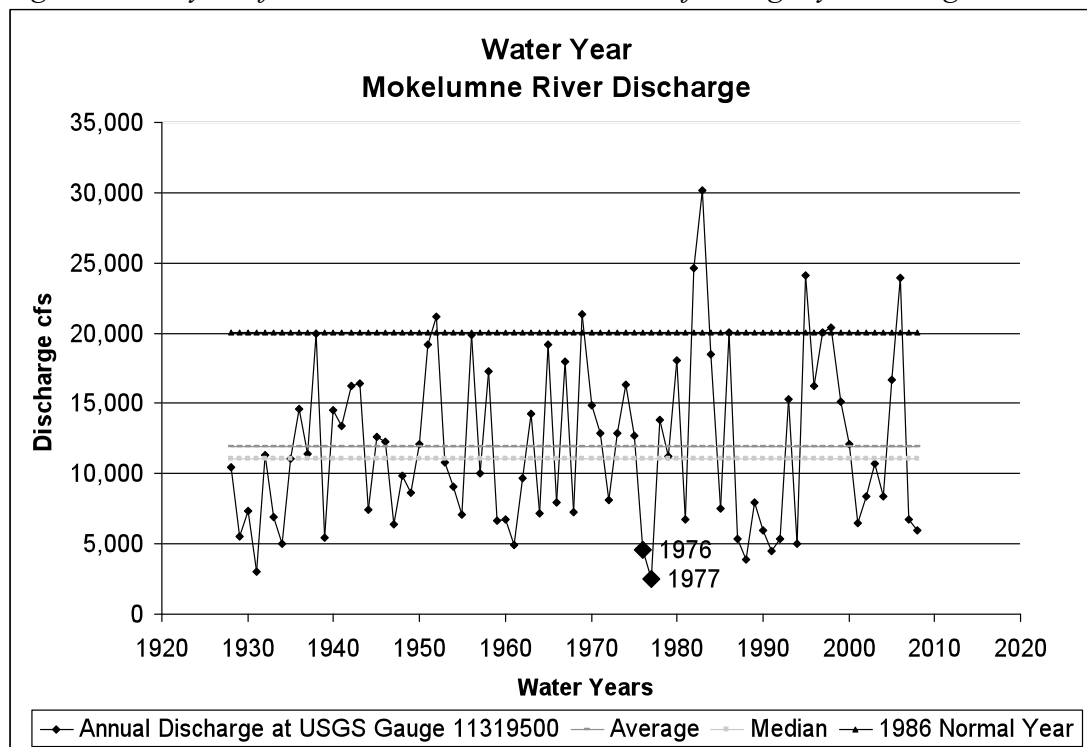


Figure 2. Analysis of EBMUD's instrumental record for multi-year drought.

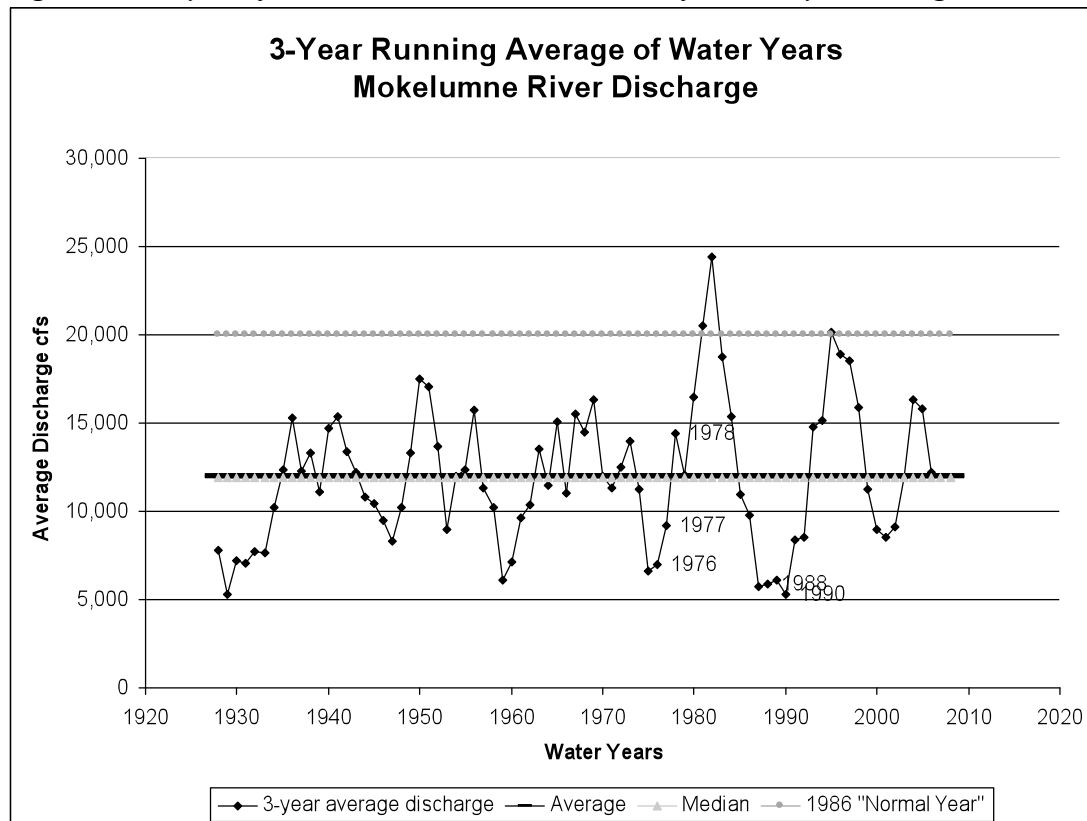


Figure 3. Paleohydrologic record within appropriate climate zone,

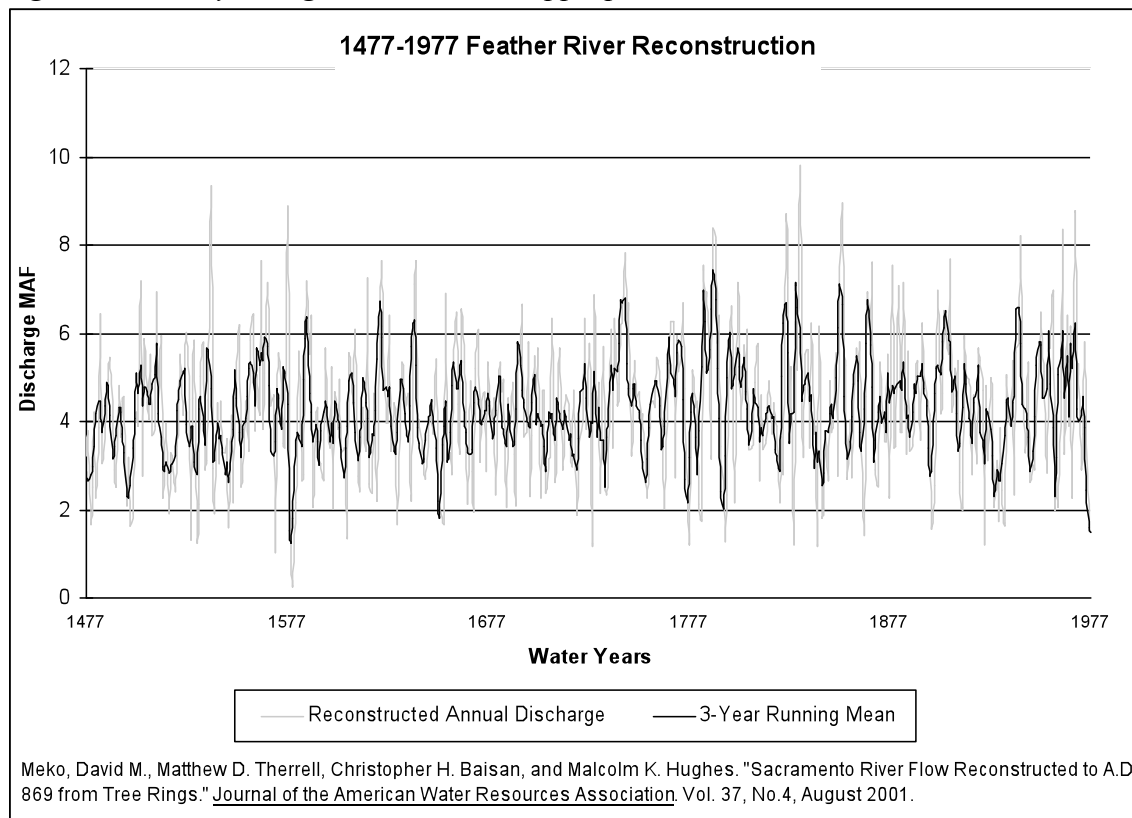


Figure4. Analysis of paleohydrologic record for drought duration and frequency compared to the instrumental record droughts.

